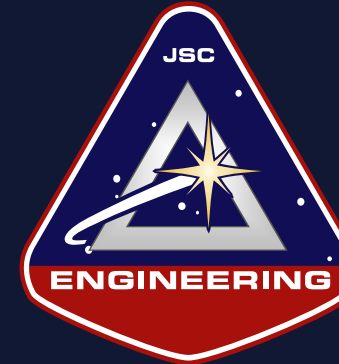




Johnson Space Center Engineering Directorate
L-8: Modeling the integration of hardware and software systems of
spacecraft using SysML
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Boilerplate

JSC Engineering: HSF Exploration Systems Development

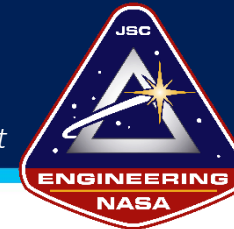


- We are sharpening our focus on Human Space Flight (HSF) Exploration Beyond Low Earth Orbit
- We want to ensure that HSF technologies are ready to take Humans to Mars in the 2030s.
 - Various Roadmaps define the needed technologies
 - We are attempting to define our activities and dependencies
- Our Goal: Get within 8 years of launching humans to Mars (L-8) by 2025
 - Develop and Mature the technologies and systems needed
 - Develop and Mature the personnel needed
- We need collaborators to make it happen, and we think they can benefit by working with us.

Boilerplate

EA Domain Implementation Plan Overview

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- Life Support
- Active Thermal Control
- EVA
- Habitation Systems

- Human System Interfaces
- Wireless & Communication Systems
- Command & Data Handling
- Radiation & EEE Parts

- Lightweight Habitable Spacecraft
- Entry, Descent, & Landing
- Autonomous Rendezvous & Docking
- Vehicle Environments



- Entry, Descent, & Landing
- Autonomous Rendezvous & Docking
- Deep Space GN&C

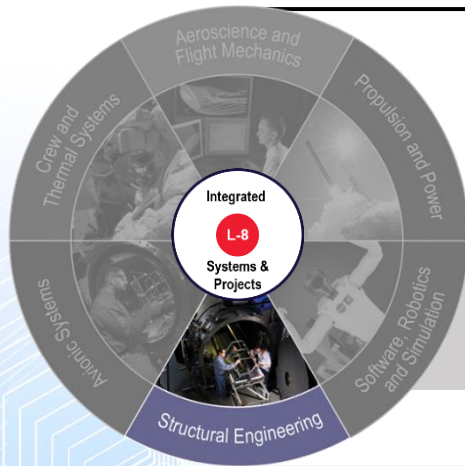
- Reliable Pyrotechnics
- Integrated Propulsion, Power, & ISRU
- Energy Storage & Distribution
- Breakthrough Power & Propulsion

- Crew Exercise
- Simulation
- Autonomy
- Software
- Robotics

Boilerplate

AA-2 | iPAS | HESTIA | Morpheus

Integrated Systems & Projects



- Integrated Test & Verification

- System Modeling

The Problem

- Space systems are becoming increasingly complex
- Space systems are becoming increasingly intelligent
- Space systems are becoming increasingly autonomous
- **Interactions among intelligent systems is not consistent and is incomplete**
- Can NASA learn from other industry experience?

Modeling the integration of hardware and software systems of spacecraft using SysML

The Effort being proposed

- We are implementing the use of a standard system modeling language (SysML) to describe space systems and their interactions

The Idea we have

- Each system can be represented at a high level and a detailed level. Any level of abstraction can be leveraged to demonstrate interfaces, activities, and states between systems

Why is collaboration a good idea?

- Complex and intelligent yet otherwise independent systems that require unattended intercommunication is common among many industries

The kind of Collaboration we envision

- Modeling methodologies, product evaluations, success criteria

The kind of partner we expect

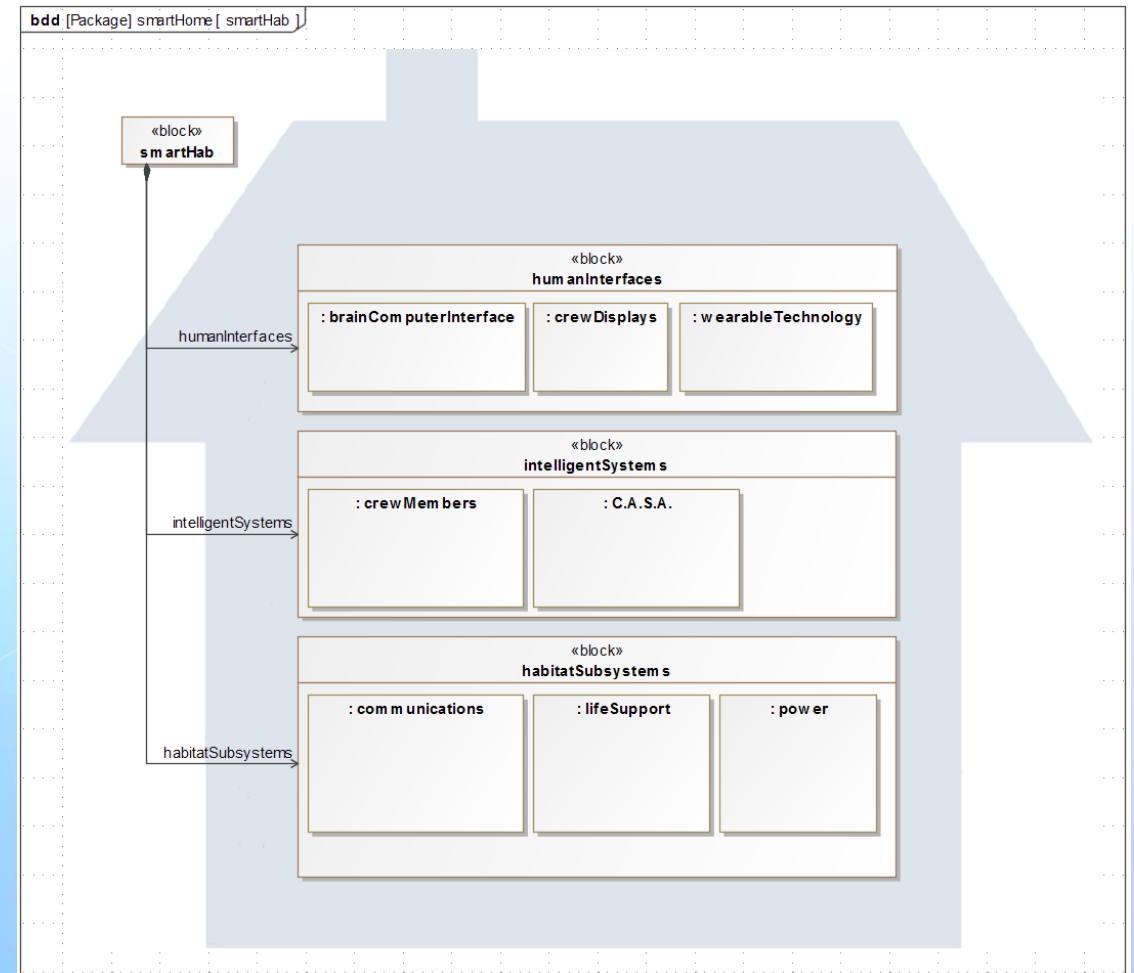
- Provider of systems analogous to space systems (smart home, manufacturing, self-driving cars, remote systems, Internet of Things)

Modeling the integration of space craft systems

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- Space systems are now smart connected systems
 - Avionics
 - Physical – sensors and actuators
 - Smart – embedded processing
 - Connectivity – wired or wireless
 - Behavior
 - Monitoring – conditions, operation
 - Control – functions, behavior
 - Autonomy - independence
- System modeling is needed to understand interactions
 - Common language for representing typically independent systems
 - Interface Description
 - Failure modes



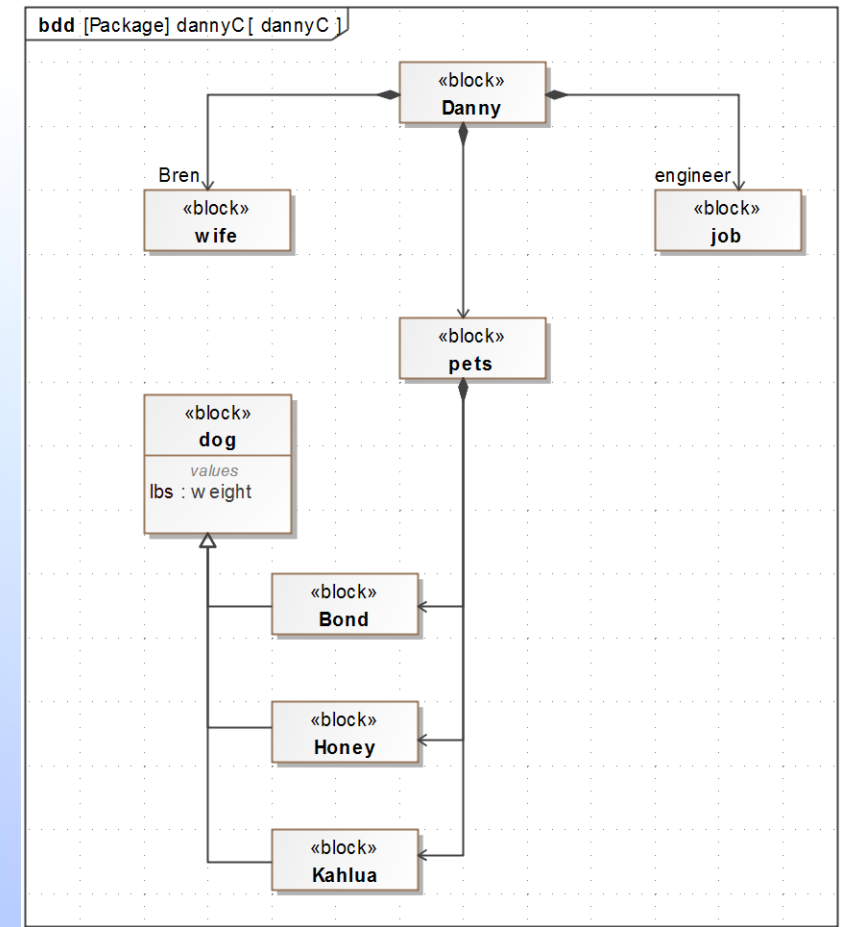
"Smart" Habitat for Deep Space Exploration

The benefits of SysML

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- What is SysML
 - OMG standard - System Modeling Language
 - General purpose graphical modeling language
- Abstraction and detail together
 - Blocks with embedded attributes
 - **Complex systems simplified**
- Hardware and Software description
 - Extension of UML
 - Co-location of hardware and software
- SysML can be used to describe technologies considered different from one another AND their interactions



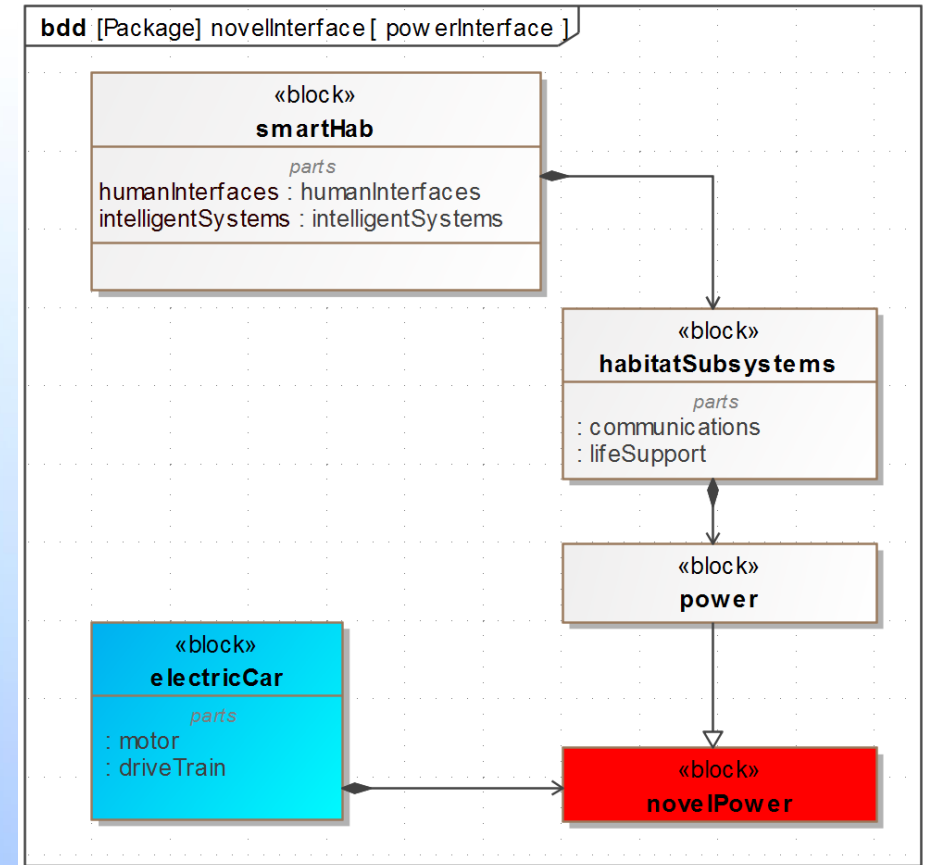
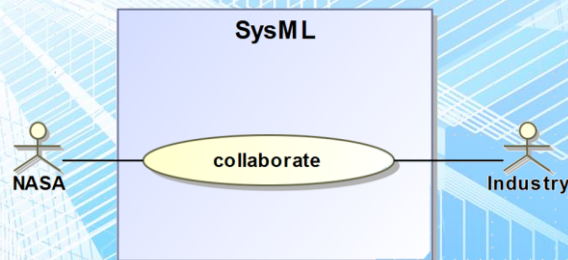
Model of complex system (family)

How we can work together

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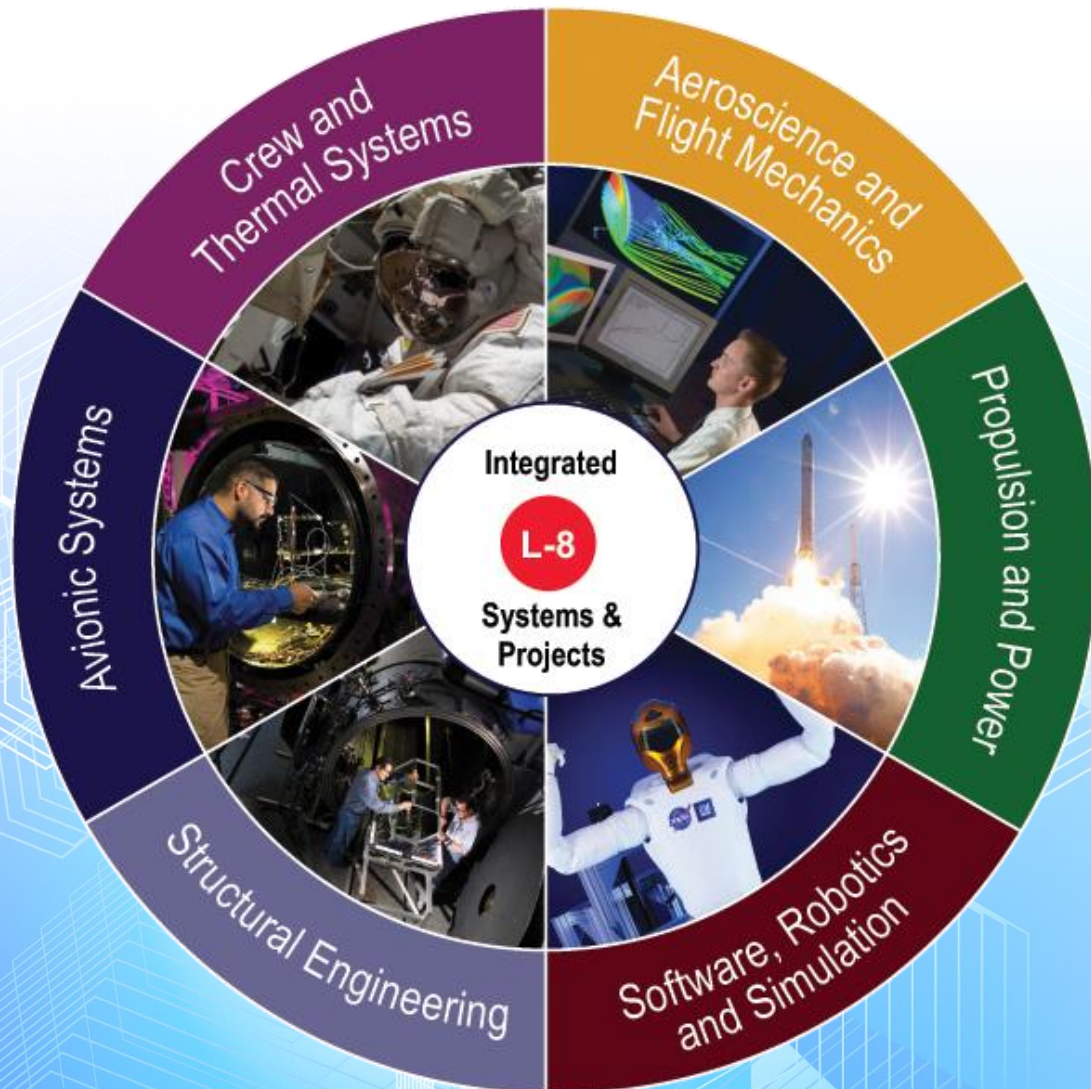


- 1 - Share models
 - Is the language really standard?
 - Does the architecting tool matter?
 - How can model libraries help?
- 2 - Start a model together
 - Choose a diverse and integrated scenario
 - Model independently yet cooperatively



Model of system shared
from one industry to another

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 - Pointer to Co-Dev Announcements
 - Pointer to intake site

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